PROJECT facts

U.S. Department of Energy
National Energy Technology Laboratory

ENVIRONMENTAL WATER AND RESOURCES

06/2000

Reclamation of Acid Coal Mine Spoils Using Wet Flue Gas Desulfurization By-Products

Description

Establishment of vegetation on abandoned surface mine spoils is required to prevent excessive erosion and stream sedimentation, reduce the amount of infiltration that could eventually lead to acidic seepage from the base of the spoil, and to improve the aesthetics of the reclaimed land. The physical and chemical conditions of acidic mine spoils must be modified in order to support vegetative growth. Covering the spoil with topsoil or borrow soil is a common practice, but this may be restricted by unavailability of suitable borrow soil or potential damage to the borrow site. There is a long history of using sewage sludge and fly ash as amendments for acid minesoils, but flue-gas desulfurization (FGD) by-products are newer materials that also show promise in these applications. "Wet" FGD processes involve the use of a slurry containing a calcium-based sorbent to remove sulfur dioxide from the flue gas of a utility boiler. The resulting by-products are mixtures of calcium sulfate ($CaSO_4$), calcium sulfite ($CaSO_3$), calcium carbonate ($CaCO_3$) and calcium hydroxide [$Ca(OH)_2$]. Fly ash is often added to a sulfite-rich by-product to improve its handling and compaction characteristics.

The primary objective of this project was to evaluate two types of wet FGD by-products for effects on vegetation establishment on acid minesoils and concurrent effects on surface and ground water quality. One FGD by-product came from the Conesville Plant of American Electric Power; it was a calcium sulfite sludge that had been stabilized with fly ash at a ratio of approximately 1:1. The other FGD material came from an experimental FGD process at the Zimmer Station of Cincinnati Gas and Electric Company that yielded a calcium sulfate (gypsum) by-product with about 4% magnesium hydroxide [$Mg(OH)_2$]. Six soil amendment types were evaluated at an acidic mine spoil site in Noble County, OH that was devoid of natural vegetation. Each FGD by-product was used as a soil amendment by itself; each by-product was also mixed with sewage sludge and used as an amendment. Local topsoil and sewage sludge were used as control amendments. All amendments except topsoil were rototilled into the spoil to a depth of 8 inches, and all plots were fertilized with P and K. Plots that did not receive sewage sludge were fertilized with commercial N. Plots were seeded with a mixture of grasses and legumes in October 1995, and four species of tree seedlings were planted in the spring of 1996. All test plots were instrumented to collect runoff water; subsurface water was collected in lysimeters at depths of 12 and 24 inches. Plant growth, plant tissue composition, soil composition, and surface and subsurface water quality were monitored for two years.

All treatments resulted in a complete cover by herbaceous plants, with the sewage sludge and FGD-amended plots resulting in plant cover that equaled or exceeded that of the control (local topsoil) plot. This showed that the FGD

PRIMARY PROJECT PARTNER

Ohio State University
Wooster, OH

MAIN SITE

Ohio Agricultural Research and Development Center
Wooster, OH
Caldwell Abandoned Mine Site
Noble County, OH

TOTAL ESTIMATED COST

$171,256

COST SHARING

DOE	$134,418
Non-DOE	$ 36,838

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materials were an effective substitute for topsoil in terms of preventing erosion after mine reclamation. Tree survival was greatest on plots amended with sewage sludge alone and poorest on the Conesville FGD treatments; however, the Conesville FGD treated plots had the highest total production of herbaceous biomass. Elevated concentrations of boron were found in the soil, vadose water, runoff water, and plant tissue associated with the FGD-amended plots, but there was no evidence of plant toxicity or reduced growth due to the elevated boron levels. With the exception of calcium, sulfate, boron and magnesium (for the Mg-gypsum plots only), there were little or no significant differences between the concentrations of dissolved constituents in vadose or runoff water of the FGD-amended plots compared to those of the control plots. In runoff water, no significant differences in the concentrations of trace metals of environmental concern (As, Ba, Be, Cd, Co, Cr, Cu, Hg, Pb, Se, Zn) were found between the control and FGD-amended plots.

Goal

To ensure the most cost-efficient delivery of electrical power, the U.S. Department of Energy (DOE) is conducting research and development to improve coal combustion by-product (CCB) management. The research program emphasizes characterization and reuse of CCBs to help stimulate markets for new materials such as those produced under the DOE's Clean Coal Technology program. Over the next 5 to 10 years, the program's goals are to develop processes leading to a 100% increase in the current rate of FGD by-product use, a 10% increase in the national rate of overall CCB use, and a 25% increase in the number of CCB applications considered "allowable" under state regulations.

Benefits

- FGD byproduct materials, alone or in combination with sewage sludge, were found to be effective, low-cost substitutes for topsoil for the purpose of establishing vegetative cover and preventing soil erosion from reclaimed surface mine sites.
- Use of FGD byproduct materials as soil amendments for surface mine reclamation did not result in an increase in the levels of heavy metal contaminants in runoff water compared to the use of topsoil.

CONTACT POINTS

Dr. David A. Kost
Ohio State University
Wooster, OH
(330) 263-3783
(330) 263-3658 fax
kost.2@osu.edu

Joel H. Beeghly
Dravo Lime Company
Pittsburgh, PA
(412) 777-0711
(412) 777-0727 (fax)
joelb@dravo.com

David M. Hyman
U.S. Department of Energy
National Energy Technology Laboratory
Pittsburgh, PA
(412) 386-6572
(412) 386-5917 fax
david.hyman@netl.doe.gov

PROJECT PARTNERS

Dravo Lime Company
Pittsburgh, PA
(FGD material supplier)

American Electric Power
Conesville, OH
(FGD material supplier)

Cincinnati Gas and Electric Company
Cincinnati, OH
(FGD material supplier)